PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventor: TERENCE WALTER GEORGE ROWE

922,493

Date of filing Complete Specification April 6, 1961.

Application Date April 12, 1960.

Complete Specification Published April 3, 1963.

No. 13090/60.

Index at acceptance: —Classes 49, D2(A:B2), D3B; and 34(2), G2E, GX3.

International Classification:—A23l (F26b).

COMPLETE SPECIFICATION

Improvements in or relating to Freezedrying of Foodstuffs

We, EDWARDS HIGH VACUUM LIMITED, a British Company, of Manor Royal, Crawley, Sussex, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to freeze-drying of foodstuffs and has for its object to provide a method of and apparatus for freeze-drying foodstuffs on a scale which is sufficiently economical and efficient to render the method and apparatus commercially advantageous.

Many known methods of freeze-drying pharmaceutical preparations are expensive and not commercially adaptable to the freeze-drying of less intrinsically valuable materials such as foodstuffs on a scale large enough for commercial purposes.

In one method of bulk freeze-drying of foodstuffs the material to be dried is in wet solid form and of uniform thickness. It is pre-frozen and placed upon water-heated cavity shelves in a chamber which is afterwards evacuated. The shelves can be moved so that they make contact with the upper and lower faces of the product. A constant pressure is applied by hydraulic or mechanical means and a linkage system is used to advance the shelves to maintain good thermal contact with the product in spite of the slight shrinkage occurring during drying. Water-heating is employed so that the high shelf temperatures maintained during the drying process, to ensure rapid heat transfer, can be rapidly reduced at the end of the drying cycle to prevent burning of the dried product. The water connections to the shelves although flexible are fairly stiff and impose an uncertain resistance to shelf movement, and it is difficult to apply, measure and maintain predetermined contact pressures on the product.

A further difficulty with the known method is that as the thermal contact is improved by pressure the passage for free escape of vapour from the surface of the material is reduced. This can lead to local melting of the product and sticking to the plates, thereby further impeding the escape of water vapour.

According to the present invention, in a method of freeze-drying material such as foodstuffs, the material is subjected to vacuum in a chamber housing a plurality of shelves constituted by heated plates or sheets between which layers of said material are sandwiched and in which controllable pressure is applied to the assembly of shelves and material. The pressure is applied by flexible bags or the equivalent, for example, bellows, containing a fluid medium such as air or liquid. The bellows may be composed of metal.

Further, according to the invention, in a method of freeze-drying material such as foodstuffs, the material is subjected to vacuum in a chamber housing a plurality of shelves of thin electrically heated sheets of low thermal mass, the material being sandwiched between adjacent shelves.

The material may be frozen by vacuum evaporation treatment before or after being placed between the plates or an assembly of plates and material to be treated may be placed in a refrigerator of the blast tunnel cooler or other suitable type.

Alternative forms of and means for carrying out the invention will now be described in greater detail, by way of example, with reference to the accompanying drawings in which:—

Figure 1 shows an elevation of a freeze-drying vacuum chamber,

Figure 2 shows an enlarged detail at A of Figure 1,

Figure 3 shows an alternative arrangement of Figure 2,

Figure 4 shows a further alternative arrangement of Figure 2,

Figure 5 shows a part elevation of an alternative freeze-drying vacuum chamber, and

Figure 6 shows an enlarged detail at B of Figure 5.

In the drawings similar items are designated like reference numerals for convenience.

Referring to Figures 1 and 2, a vacuum chamber 1 of known type contains foodstuff 2 placed between shelves 3 of thin metal sheets each having a heating element 10 and being of low thermal mass due to their thickness.

The shelves 3 are clamped together by rods 4 and pneumatic bags 6 are disposed between either or both of the two end shelves and the adjacent wall of the vacuum chamber, the bags enabling accurate control of the pressure applied through the shelves to the material being dried. A support plate 5 or plates may be used to interleave the shelves to relieve undue pressure at the bottom of the stack. When more than one support plate is used additional pneumatic bags must be provided so that shelves between intermediate support plates are compressed.

In Figure 2 the shelves 3 contain heater elements 10 and are sandwiched between expanded metal sheets 7. The foodstuff 2 is placed between the expanded metal sheets 7 which provide both points 8 for intimate contact with the foodstuff and channels 9 for vapour flow.

In Figure 3 the shelves 3 contain heater elements 10 and alternate shelves are sandwiched between expanded metal sheets 7. The food stuff 2 is frozen between the shelves in such a way that no vapour can escape from the side which has no expanded metal between it and the shelf. The foodstuff receives heat on one side by direct conduction from the shelf, and on the other side by conduction through the expanded metal sheet 7, conduction through evolving vapour and direct radiation from the shelf. As in Fig. 2 the sheets 7 provide both poins 8 for intimate contact with the foodstuffs and channels 9 for vapour flow.

In the further alternative shown in Figure 4 the shelves comprise a heater element 10 bonded between ribbed or embossed metal sheets 13 which provide the points of intimate contact 2 and channels 9 for vapour flow.

In a further alternative, not illustrated, the shelves contain heater elements and each shelf has an expanded metal sheet on one side only. Thus, heat is transferred from the shelf to the foodstuff by direct contact on one side and through the expanded metal on the other side.

The vacuum chamber shown in Figure 5 is similar to that shown in Figure 1 except that instead of having interleaving plates 5 to relieve undue pressure at the bottom of the stack, the shelves are separated by springs 14 of suitably graded strength so that each spring just supports the combined weight of the shelves and foodstuff above it. Thus the pressure exerted by the pneumatic bags is equally distributed at all levels and is not supplemented on the lower shelves by the weight of the shelves and foodstuff above.

In general the material to be freeze-dried which may be a fluid containing solids, or a solid containing moisture, may be pre-frozen and then stacked in the form of a multiple sandwich between the heated shelves, or the whole assembly of foodstuff and shelves may be refrigerated in a blast tunnel or other suitable cooler. This method overcomes an existing objection that pre-frozen material melts when placed on massive warm shelves unless the vacuum is rapidly obtained in the freeze-dryer. If the material is to be placed on the expanded metal or other mesh sheets before freezing, these sheets may be treated with silicon or like preparation to prevent the material sticking to them. Alternatively the material in the stack may be evaporatively frozen in the vacuum chamber, the low thermal mass of the shelves preventing excessive loss of moisture from the liquid state during freezing.

The expanded metal sheets, the meshed sheets and the ribbed or embossed sheets used in the above described alternatives for the shelves may be replaced by knitted, coiled, crimped or woven wire mesh or any other suitable open structure material whether metal or otherwise. The various alternative forms all serve to make good thermal contact with the foodstuff being treated while allowing escape of vapour during the drying of the foodstuff. The meshlike material preferably, though not necessarily, has some compressibility and flexibility to improve the thermal contact with the foodstuff.

The stack of shelves and material to be treated may be stood on edge in the vacuum chamber thereby relieving undue pressure on the bottom of the stack which would occur if the stack were kept vertical and interleaving plates were omitted. In order that movement of the material to be treated on the shelves is prevented when the stack is stood on edge, the shelves are clamped together in a manner as described or otherwise clamping of the shelves is employed even in a vertical stack for the purposes of locating the shelves and facilitating handling.

The pneumatic bags 6 used in the described alternatives for applying pressure to the material to be treated may be replaced by metal bellows and either may be operated pneumatically or hydraulically. Whichever form of pressure applying means is used it has

the effect of reducing the pressure differential due to atmospheric pressure acting on the outside wall of the vacuum chamber and pressures up to at least 14.7 lbs p.s.i. can be applied on the material to be treated. This is without any outward thrust acting on the walls of the vacuum chamber. If desired, higher pressures may be applied by pumping.

As the interior of the chamber is under vacuum, it is normally unnecessary to pump air into the bags but merely to permit air to flow into them when they will expand due to the low surrounding pressure. Instead of air or other suitable gas, a liquid may be used to cause the bags to apply the desired pressure to the stack. The bags may be composed of any appropriate air or liquid-tight material such as synthetic rubber reinforced with canvas or nylon.

The method of controlling the applied pressure using pneumatic bags, may of course, be applied to a vertical stack of material and heater plates as well as to a horizontal assembly.

Although reference has been made to the use of electrically-heated metal sheets, it will be understood that in certain applications of the invention, other known forms of heating as by water or steam, may be used. Again, the heated plates need not be of metal but, particularly when electrically-heated, they may be made of a heat-resisting synthetic resin such as an epoxy resin reinforced if necessary.

When heated metal sheets are used they may take the form of thin sheets in which labyrinths are formed in known manner by hydraulic expansion or pneumatic expansion. The labyrinths may be of serpentine form and may be used to accommodate any appropriate form of heating or cooling medium.

As such labyrinths stand proud of the faces of the sheets, they may serve the purpose of the expanded metal sheets previously referred to or channels of selected shape may be specially formed in the faces of the sheets.

WHAT WE CLAIM IS:—

1. A method of freeze-drying material such as foodstuffs, comprising subjecting the material to vacuum in a chamber housing a plurality of shelves constituted by heated plates or sheets between which layers of said material are sandwiched, and applying controlled pressure to the assembly of shelves and material by means of flexible bags, for example, bellows containing a fluid medium.

2. A method according to Claim 1 in which the bags or bellows are pneumatically operated.

3. A method according to Claim 1 in which the bags or bellows are hydraulically operated.

4. A method of freeze-drying material such as food-stuffs, as claimed in Claim 1 in which the shelves are thin electrically heated sheets of low thermal mass.

5. A method according to any one of the preceding claims in which the material is frozen by vacuum evaporation treatment prior to being placed between said shelves.

6. A method according to any one of Claims 1—4 in which the assembly of shelves and material is cooled prior to being located in the vacuum chamber.

7. A method according to Claim 6 in which the assembly of shelves and material is cooled by a refrigerator of the blast tunnel cooler type.

8. A method according to any one of the preceding claims in which at least one face of the foodstuff being dried is supported so that there is both good thermal contact between the face of the shelf and the said material and space through which vapour evolved during the drying process may flow.

9. A method according to any one of the preceding claims in which the shelves are of metal.

10. A method according to any one of the preceding claims in which the surfaces of said shelves which contact said material are treated with a preparation to prevent adhesion of the material thereto.

11. A method according to Claim 10 in which said surfaces of the shelves are treated with silicone.

12. Apparatus for carrying out the methods of freeze-drying material substantially as described hereinbefore with reference to Figures 1 and 2, or as modified by Figures 3 and 4, or with reference to Figures 5 and 6 of the accompanying drawings.

ABEL & IMRAY,
Chartered Patent Agents,
Quality House, Quality Court,
Chancery Lane, London, W.C.2.

Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1963.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

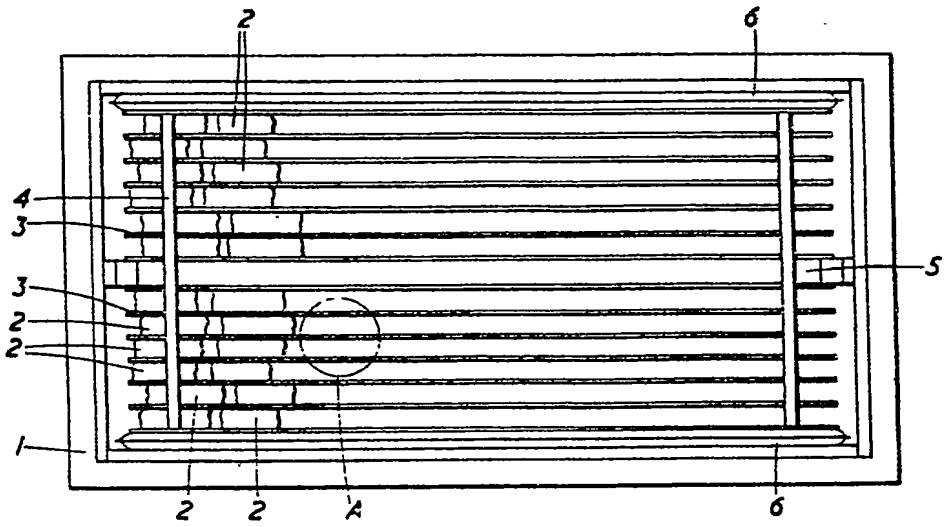

FIG. 1.

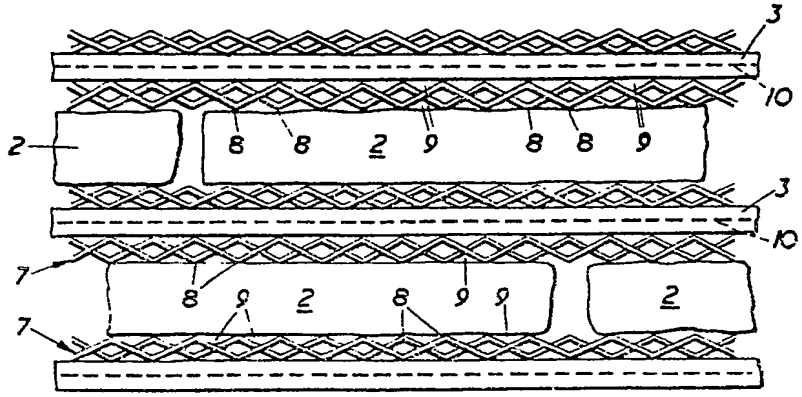

FIG. 2.

922,493 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*
SHEETS 1 & 2

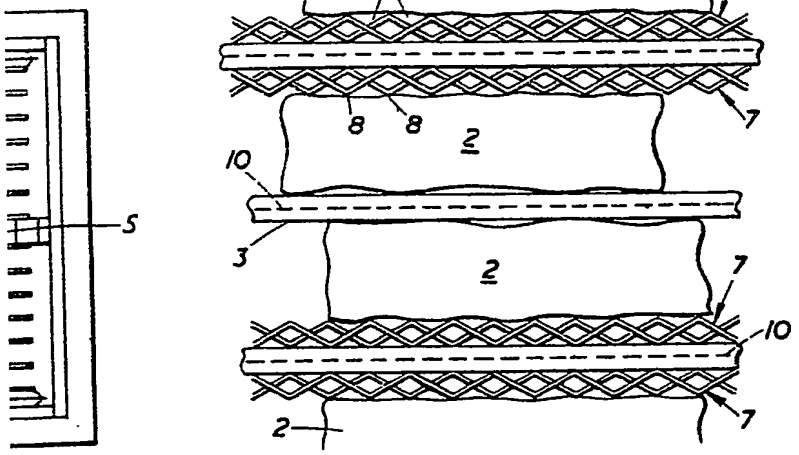

FIG. 3.

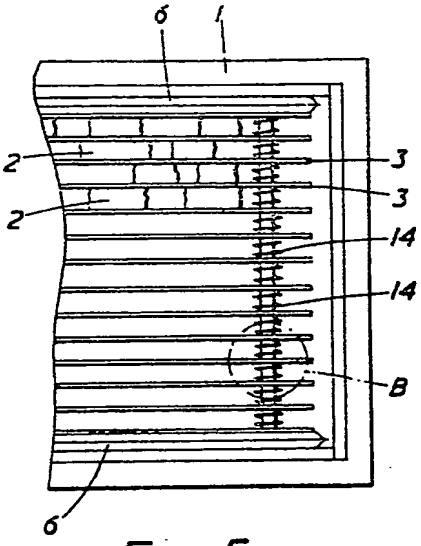

FIG. 5.

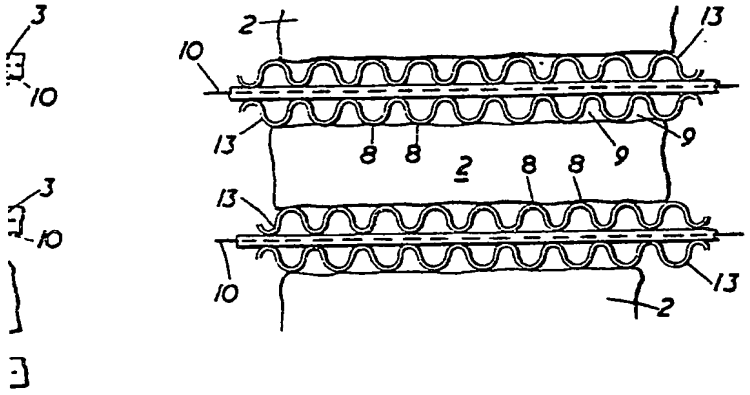

FIG. 4.

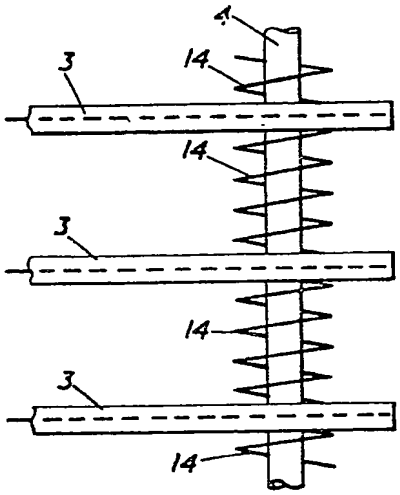

FIG. 6.

922,493 COMPLETE SPECIFICATION
2 SHEETS

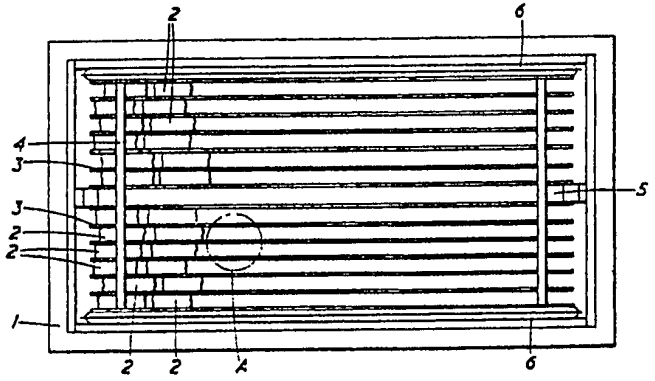

FIG. 1.

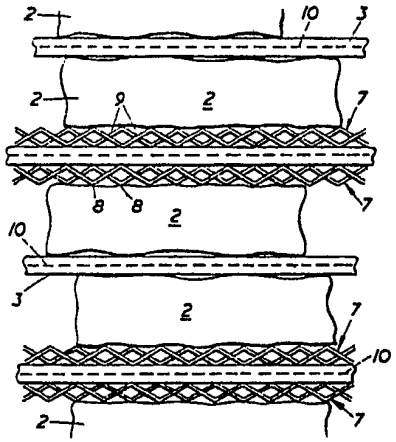

FIG. 3.

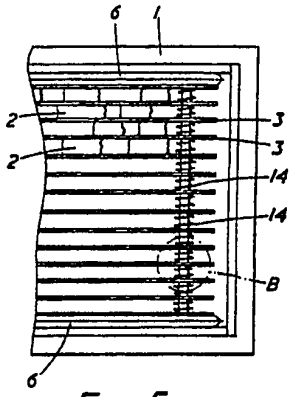

FIG. 5.

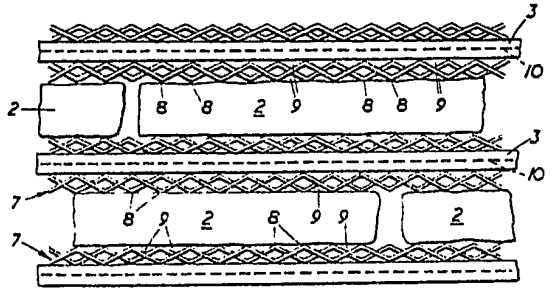

FIG. 2.

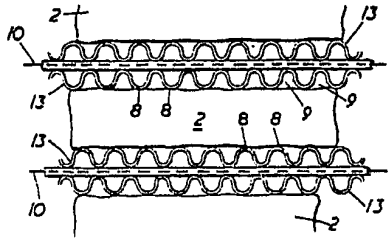

FIG. 4.

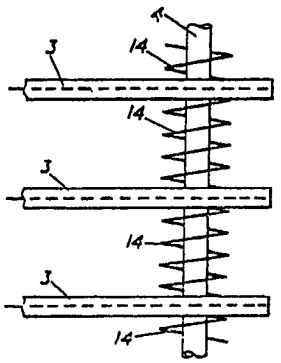

FIG. 6.